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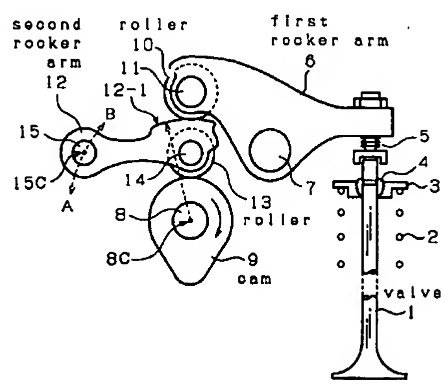
(54) Valve operating system for internal combustion engine

(57) In a valve operating system for an internal combustion engine having a rocker arm 12 permitting alteration of lift timing of valve 1 by shifting the rocking fulcrum, a roller for attaining a rolling contact is provided at least at one of the contacting positions on the driving force-delivering way between a cam for providing a driving force and a valve. Thus, a force necessary for driving the cam can be reduced even with a multi-cylinder internal combustion.

In addition, one contact surface on the driving force-delivering way is made a circular surface with the center of the shaft 8 of the cam 9 as its center. In altering the relation between the valve-lifting degree and lift timing, the rocking fulcrum 15C of the second rocker arm 12 is properly shifted in the direction shown by the arrow A or B. The above-described circular surface serves for the rocker arm 6 not to be shifted upon alteration described above.

An increase in surface-to-surface pressure per unit area at the contact surface can be avoided by employing such structure that the cam 9 and the second rocker arm do not axially deviate from each other. Employment of a mechanically strong mechanism using gears or the like as a mechanism for controlling the position of said rocking fulcrum 15C.

Fig. 5



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Description

Field of the Invention

This invention relates to a valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting its rocking fulcrum.

Background of the Invention

Some valve operating systems have a rocker arm, whose rocking fulcrum can be shifted, provided at a position between a cam for supplying a driving force for moving a valve to open or close and the stem of the valve to which the driving force is to be delivered. Valve lift timing can be altered as the case demands by shifting the rocking fulcrum of the rocker arm along the circle with the center of the cam as its center.

Hereinafter, a conventional rocker arm not permitting alteration of rocking fulcrum is referred to as a first rocker arm, and a rocker arm permitting alteration of rocking fulcrum is referred to as a second rocker arm.

Fig. 1 shows such conventional valve operating system for an internal combustion engine. In Fig. 1, numeral 9 designates a cam, 8 a shaft, 8C a center of shaft 8, 12 a second rocker arm, 15 a shaft, 15C a center of shaft 15, 64 a first rocker arm, 6-1 a guide groove, 7 a shaft, 1 a valve, 20 a lever for altering valve lift timing, and A and B arrows. Both of the first rocker arm 6 and the second rocker arm 12 are of end pivot type having a rocking fulcrum at one end. The shaft 8 of the cam 9 and the shaft 15 of the second rocker arm 12 are supported by the lever 20 for altering valve lift timing.

The cam 9 is in sliding contact with the upper surface of the second rocker arm 12, and the tip end of the second rocker arm 12 is fitted with the guide groove 6-1 provided in the upper portion of the rocker arm 6 to contact. The guide groove 6-1 is provided for the tip end not to come out of the rocker arm 6. The lower end of the rocker arm 6 is in contact with the stem of the valve 1, with the valve 1 being opened upon the stem being pushed downward.

Fig. 2 illustrates the lever 20 for altering valve lift timing. Signs correspond to those in Fig. 1, with 20-1 and 20-2 designating supporting holes, 20-3 an end-connecting portion, 21 a return spring, and 22 a wire. Both ends of the shaft 8 of the cam 9 penetrate through the holes 20-1, whereas both ends of the shaft 15 of the second rocker arm 12 penetrate through the supporting holes 20-2. One end of the wire 22 is connected to an about central portion of the end-connecting portion 20-3, and the return spring 21 is provided on each side of the lever 20 for altering valve lift timing.

Since the shaft 8 of the cam 9 is fixedly disposed, the lever 20 for altering valve lift timing is swung in the direction shown by the arrow B when the wire 22 is pulled in the direction shown by the arrow, or is swung in the direction shown by the arrow A due to the biasing force of the return spring 21 when the wire 22-pulling force is weakened. This swinging motion causes the shaft 15 penetrating through the supporting hols 20-2 to swing in the direction shown by the arrow A or B as shown in Fig. 1. The direction shown by the arrow A or B is along the circle with the center 8C of the shaft 8 of the cam 9 as its center.

In the case of altering the relation between the valve-lifting degree and lift timing, the shaft 15 of the second rocker arm 12 is shifted in the direction shown by the arrow A or B through the above-described swinging motion.

Fig. 3 is a graph showing a valve lift curve, with time (of timing) as abscissa and valve-lifting degree as ordinate. The valve lift curve is a characteristic curve showing the relation between the valve-lifting degree and lift timing. Curve S is a curve when the center 15C of the shaft 15 is at a standard position. Curve A is a curve when the center 15C is shifted in the circular direction A shown in Fig. 1 with the center 8C of the shaft 8 as a center of the circle. Such shift is suited for obtaining a higher power from an internal combustion engine. Curve B is a curve when shifted in the direction B. Such shift is suited for obtaining a lower power from the internal combustion engine.

Additionally, valve operating systems for an internal combustion engine as described above are described in, for example, Japanese Unexamined Patent Publication No. 64-53009.

However, the aforesaid conventional valve operating system for an internal combustion engine has following problems. A first problem is that, when employed in a multi-cylinder internal combustion engines, quite a large power is required for driving the valve operating system.

As can be seen from Fig. 1, there exist several slidingly contacting portions in the aforesaid valve operating system on the driving force-delivering way between the cam 9 and the valve 1. That is, the cam 9 and the second rocker arm 12 are in sliding contact with each other, and the tip end of the second rocker arm 12 and the guide groove 6-1 are in sliding contact with each other. In delivering a driving force through such sliding contact, not only a driving force but a force overcoming the friction force of the sliding contact on the driving force-delivering way must be provided.

Therefore, multi-cylinder engines require quite a strong force since the aforesaid friction force is multipled, though not so much with single cylinder engines. Since the force for rotating the cam 9 is also provided from the engine, there eventually results an increased engine load.

A second problem of the aforesaid conventional valve operating system for an internal combustion engine is that the cam 9 and the second rocker arm 12 can get out of relative position or deviate in the axial direction, which leads to a decrease in contact area therebetween, resulting in such troubles as an increase in surface-to-surface pressure per unit area applied to the contact surfaces.

Fig. 4 illustrates the cam 9 and the second rocker arm 12 in the axially deviating state. D represents the deviation degree. The second rocker arm 12 is supported in relation to the shaft 8 of the cam 9 by means of the lever 20 for altering valve lift timing as is shown by Fig. 1. However, no special means are provided for properly positioning them in the longitudinal or axial direction of the shaft.

Therefore, in the course of long-time operation, the cam 9 and the second rocker arm 12 in contact with each other can deviate relatively in the axial direction. As the deviation degree, D, increases, the contact area between the cam 9 and the second rocker arm 12 decreases. Since the force delivered from the cam 9 is the same, the force applied to unit area of the contact area (surface-to-surface pressure per unit area) increases, which causes damage of the contact surface.

A third problem with the aforesaid conventional valve operating system for an internal combustion engine is that, since a controlling member for altering valve lift timing has not enough rigidity (to deliver controlling force), control of valve lift timing has not been conducted with high accuracy and responsiveness particularly in a multi-cylinder internal combustion engine.

Alteration of valve lift timing is conducted by pulling the valve lift timing-altering lever 20 with the wire 22 or by allowing to return to place through the biasing force of the return spring 21, as shown in Fig. 1. In general, however, wires will be stretched to some extent, and strength of the return spring will change after long use. In addition, with a multi-cylinder engine, all valves are different from each other in valve-operating conditions, and forces resisting the controlling force by the wire 22 or the return spring 21 vary.

For example, a force delivered to each second rocker arm (12 in Fig. 1) from the spring (2 in Fig. 5) provided around the valve differs depending upon the position of each valve (1 in Fig. 1) in each cylinder. Therefore, in the case of returning in the direction shown by the arrow A through the biasing force of the return sprig 21, resisting force differs depending upon the stage. Therefore, when the resisting force is large, the controlling force can not be delivered rapidly, failing to conduct the control with high accuracy and responsiveness.

Disclosure of the Invention

In order to solve the first problem described hereinbefore, the present invention provides a valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which
a roller for attaining a rolling contact is provided at least at one of the contacting positions on the driving force-delivering way between a cam for providing a driving force and a valve, and one contact surface on the driving force-delivering way is made a circular surface with the center of said cam as its center.

Additionally, in another embodiment, a first and a second rocker arms may be used as the rocker arm. In this embodiment, the first rocker arm has at one end a means for fittingly contacting with the aforesaid stem of the valve and at the other end a circular surface with the center of the aforesaid cam as its center, and the second rocker arm has a rocking fulcrum shiftable upon alteration of valve lift timing and has at the rocking tip end a first roller in contact with said circular surface and a second roller in contact with said cam with both rollers on the same shaft.

In order to solve the second problem described hereinbefore, the present invention provides a valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a bracket, engagedly fitted to a cam shaft, through which a shaft for said rocker arm penetrates at its one end and which is engagedly fitted to a shaft of the cam functioning as a source of driving force is provided, said engaged fitting being formed by a combination of a depression and a projection to prevent deviation in the axial direction of the shaft.

In order to solve the third problem described hereinbefore, the present invention provides a valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a bracket, engagedly fitted to a cam shaft, which intervenes between said shaft and a cam shaft; a valve lift timing-altering shaft rockable by the force delivered from a driving means; and a fork lever one end of which is fixed to said valve lift timing-altering shaft and whose fork grooves are fitted to said shaft are provided

Additionally, in another embodiment, the valve operating system may have a bracket, engagedly fitted to a cam shaft, which intervenes between said shaft and a cam shaft; a valve lift timing-altering shaft rockable by the force delivered from a driving means; and a gear mechanism having a gear fixed to said valve lift timing-altering shaft and a gear engaged with the gear and fixed to said shaft.

Brief Description of the Drawings

Fig. 1 illustrates a conventional valve operating system of an internal combustion engine.

Fig. 2 illustrates a lever for altering valve lift timing.

Fig. 3 is a graph showing a valve lift curve.

Fig. 4 illustrates axial deviation between a cam and a second rocker arm.

Fig. 5 illustrates a first example of the present invention.

Fig. 6 illustrates a second example of the present invention.

Fig. 7] illustrates a third example of the present invention.

Fig. 8] illustrates a fourth example of the present invention.

Fig. 9] illustrates a fifth example of the present invention.

Fig. 10] illustrates a sixth example of the present invention.

. Fig. 11] illustrates a seventh example of the present invention.

Fig. 12 illustrates an eighth example of the present invention.

Fig. 13 is a plan view of a second rocker arm.

Fig. 14 is a perspective view of the eighth example of the present invention.

Fig. 15 illustrates a deviation-preventing mechanism of the present invention in a valve operating system.

Fig. 16 illustrates a bracket to be engagedly fitted to a cam shaft.

Fig. 17 is a perspective view of a ninth example of the present invention.

Fig. 18 illustrates a bracket of the ninth example to be engagedly fitted to a cam shaft.

Best Mode of the Invention

The present invention is now described in more detail by reference to examples based on the drawings.

In the first to seventh examples, at least one of the slidingly contacting portions existing mainly on the driving force-delivering way between cam and valve is replaced by a rolling contact portion, in a valve operating system of an internal combustion engine having a rocker arm permitting alteration of valve-lifting time by shifting rocking fulcrum, thus reducing the necessary force for operating the valve operating system.

In the eighth example, axial deviation between the cam 9 which delivers a force to operate the valve and the second rocker arm 12 is prevented in addition to the reduction of the force for operating the valve operating system by using rollers.

(First Example)

Fig. 5 shows a first example of the present invention. Signs correpond to those described in Fig. 1. Numeral 2 designates a spring, 3 a spring sheet, 4 a cotter, 5 an adjuster, 10 a roller, 11 a shaft, 12-1 a contact surface, 13 a roller, and 14 a shaft. The same signs as in Fig. 1 have the same meaning, description thereof being omitted.

The roller 13 is fitted to the tip end of the second rocker arm and is in contact with the cam 9. The shaft 14 is a shaft for the roller 13. One end of the first rocker arm 6 is fittingly contacted with the valve stem of the valve 1 through the adjuster 5, and the other end has a roller 10 fitted thereto by the shaft 11. The contact surface 12-1 of the second rocker arm 12 is in contact with the first rocker arm 6 through the roller 10.

The contact surface 12-1 is formed as a circular surface with the center 8C of the shaft as its center. Because, such circular form serves for the first rocker arm 6 not to be shifted upon shifting the center 15C of the shaft 15 in the direction of A or B. (In the following other examples, circular surfaces with the center 8C as their center, if used, are made circular for the same reason.) Since the center 15C is shifted in the direction shown by the circular arrow A or B with the center 8C as its center, the contact surface 12-1 which is in a circular form also with the center 8C as its center merely migrates along the same circle when the center 15C is shifted, thus not pushing the rocker arm 6 upword or downward.

When the cam 9 is rotated, the second rocker arm 12 is pushed upward through the roller 13 and, in turn, one end of the first rocker arm 6 is pushed upward through the roller 10 in contact with its contact surface 12-1. The first rocker arm 6 makes a circular motion, and the adjuster 5 fitted at the other end of the arm pushed the valve 1 downward.

When the upwardly pusing force by the cam 9 disappears, the valve 1, the first rocker arm 6 and the second rocker arm 12 return to the initial positions due to the biasing force of the spring 2.

Since all contact portions on the driving force-delivering way between the cam 9 and the first rocker arm 6 are of the rolling contact type, the force for driving the cam 9 is so much reduced in comparison with the conventional type that a multi-cylinder engine can be driven by a reduced force.

(Second Example)

Fig. 6 illustrates a second example of the present invention. Signs correspond to those in Fig. 5, with 6-1 designating a contact surface, 16 a roller and 17 a shaft. In this example, rollers are provided only in the second rocker arm. The roller 13 is fitted in the middle of the second rocker arm 12, and the roller 16 at the tip end. The cam 9 is in contact with the roller 13, and the first rocker arm 6 is in contact with the roller 16.

In this example, too, all of contact portions on the driving force-delivering way between the cam 9 and the first rocker arm 6 are of rolling contact through roller, thus driving force being reduced. Additionally, the contact surface 6-1 in contact with the roller 16 has a circular surface with the center 8C of the shaft 8 as its center. In altering the valve lift timing, the center 15C of the shaft 15 is shifted in the direction shown by the arrow A or B.

(Third Example)

Fig. 7 illustrates a third example of the present invention. Fig. 7 (a) and (b) respectively illustrate two embodiments of the third example. Signs correspond to those in Figs. 5 and 6. The third example is intended to decrease production cost, reduce cam-driving force and lower height of the valve operating system by using only one roller.

The cam 9 and the second rocker arm 12 are in contact with each other through the roller 13, but the contact surface of the second rocker arm 12 and the contact surface 6-1 of the first rocker arm 6 are in contact with each

other without any roller. Since only one roller is used for the contact portion with the cam 9, friction force is larger than in the example wherein rollers are used in all contact portions (for example, Fig. 6). However, omission of one roller serves to lower the height of the valve operating system and decrease production cost in comparison with such examples as shown by Fig. 6. Therefore, in the case where the number of cylinders is not so large, this example suffices.

(Fourth Example)

Fig. 8 illustrates a fourth example of the present invention. Signs correspond to those in Fig. 7. This example is also intended to decrease production cost, reduce the force for driving a cam, and lower the height of valve operating system by employing only one roller. A surface 12-2 in contact with the cam 9 of the second rocker arm 12 is made flat, and a surface 12-1 in contact with the roller 10 of the first rocker arm 6 is of a circular shape with the center 8C of the shaft 8 as its center.

The fourth example is different from the third example in the position to which the roller is fitted. In the third example, the roller is fitted to the second rocker arm 12, whereas in the fourth example, the roller is fitted to the first rocker arm 6.

(Fifth Example)

Fig. 9 illustrates a fifth example of the present invention. In this example, not only the second rocker arm 12 but the first rocker arm 6 is of a so-called end pivot type wherein the shaft 7 is provided at one end section. Two rollers 10 and 13 are disposed in an in-line manner as in the example shown by Fig. 5. The contact surface 12-1 of the second rocker arm 12 is of a circular shape with the center 8C of the cam 9 as its center.

(Sixth Example)

Fig. 10 illustrates a sixth example of the present invention. Signs correspond to those in Figs. 5 and 6, with numeral 18 designating a tappet and 19 a shim. (Additionally, since only the first rocker arm 6 is used as the rocker arm in this example, it is merely referred to as "rocker arm".) This is an example of applying the present invention to a valve operating system of direct attack type.

The shim 19 is provided on top of the tappet 18 and in contact with the contact surface 6-1 of the end pivot type rocker arm 6. The contact surface 6-1 is of a circular shape with the center 8C of the shaft 8 as its center. The roller 10 is fitted to the rocker arm 6, and is in contact with the cam 9. The contact between the rocker arm 6 and the cam 9 is a rolling contact with the roller therebetween, thus the force for driving the cam 9 being reduced.

The relation between valve-lifting degree and valve lift timing can be altered by shifting the center 7C of the sahft 7 of the rocker arm 6 in the direction A or B along the circle with the 8C of the shaft 8 of the cam 9 as its center. Since the contact surface 6-1 is of a circular shape with the center 8C of the shaft 8 as its center, it does not push the shim downward even when the center 7C of the shaft 7 is shifted as described above.

(Seventh Example)

Fig. 11 illustrates a seventh example of the present invention. Signs correspond to those in Fig. 10, with 19-1 designating the surface of shim. The shim surface 19-1 is of a circular shape with the center 8C of the shaft 8 of the cam 9. The roller 10 fitted to the tip end of the rocker arm 6 is in contact with the shim surface 19-1. The contact surface 6-1 of the rocker arm 6 is flat and is in sliding contact with the cam 9. As to other points, the same applies as in the example shown by Fig. 10.

(Eighth Example)

Fig. 12 illustrates an eighth example of the present invention. Fig. 13 is a plan view of the second rocker arm 12 used in this example. Signs correspond to those in Figs. 5 and 6, with 13-1 and 13-2 designating rollers. In this example, two rollers 13-1 and 13-2 are fitted at the tip end of the second rocker arm 12 on the same shaft (shaft 14). And, as is seen in Fig. 3, the roller 13-1 is in contact with the cam 9, whereas the roller 13-2 is in contact with the first rocker arm 6.

In the examples shown by Figs. 5 and 6, the two rollers are disposed within the plane in the longitudinal direction of the second rocker arm 12 or, so to speak, disposed in a spacially in-line manner. Therefore, height of the valve operating system becomes higher. The eighth example is intended to lower the height of the system even slightly. In the eighth example, the two rollers 13-1 and 13-2 are disposed side by side in the transverse direction with respect to the longitudinal direction of the second rocker arm 12, and hence height of the valve operating system can be reduced in comparison with the examples shown in Figs. 5 and 6. As to other points, the same applies as the example shown in Fig. 6.

When the cam 9 is rotated, the second rocker arm 12 is pushed upward through the roller 13-1 and, in turn, the contact surface 6-1 of the first rocker arm 6 is pushed upward through the roller 13-2. The first rocker arm 6 makes a circular motion, and the adjuster 5 fitted at the other end of the arm pushes the valve 1 downward. When the upwardly pusing force by the cam 9 disappears, the valve 1, the first rocker arm 6 and the second rocker arm 12 return to the initial positions due to the biasing force of the spring 2.

Fig.14 is a perspective view showing the main portion of the valve operating system of the eighth example of the present invention. Signs correspond to those in Fig. 12, with numeral 23 designating a bracket engagedly fitted to the cam shaft, 24 a shaft for altering valve lift timing, 25 a supporting member, 26 a fork lever, and 27 a pin. The shaft 24 for altering valve lift timing is

engagedly fitted to the supporting member 25, and a gear 32 is fitted at its end section and is engaged with a pinion 31. The pinion 31 is connected to a motor 30. Upon alteration of valve lift timing, the motor 30 is droven according to an order from a controller not shown to rotate the pinion 31 clockwise or counterclockwise, thus the valve lift timing-altering shaft 24 being rotated.

The fork lever 26 is fixedly fitted, at its one end, to the shaft 24 for altering valve lift timing with the aid of pins 27. The shaft 15, which is a rocking axis of the second rocker arm 12, is fitted to the fork groove of the fork lever 26. When the shaft 24 for altering valve lift timing is rotated, the fork lever 26 is swung in the direction shown by the arrow A or B.

On the other hand, to the shaft 8 extending to the both sides of the cam 9 are engagedly fitted the brackets 23.

Fig 16 illustrates the bracket 23 to be engagedly fitted to the cam shaft. Numeral 23-1 and 23-2 each designates a half-devided piece of the bracket, 23-3 a hole for penetration of shaft, 23-4 a bolt, and 23-5 a bolt hole. The engaged fitting can be conducted by holding the shaft 8 between the half-devided pieces 23-1 and 23-2, then driving the bolts 23-4 into the bolt holes 23-5. The shaft 15 shown in Fig. 14 penetrates through the shaft-penetrating hole 23 -3.

Returning to Fig. 14, the shaft 15 of the second rocker arm 12 is fixedly supported to the non-shiftable shaft 24 for altering valve lift timing through the fork lever 26, and fixedly supported to the non-shiftable shaft 8 through the bracket 23 engagedly fitted to the cam shaft. Thus, the shaft 15 can be shifted by the swinging motion of the fork lever 26, thereby valve lift timing being altered.

Controlling force for altering valve lift timing is delivered in the followng order: motor 30 (driving means)→ pinion 31→gear 32→shaft 24 for altering valve lift timing→fork lever 26→shaft 15 (final member to be driven).

Since all constituents in this delivering route have mechanically strong structures, a highly rigid controlling system is constituted. That is, even with a multi-cylinder internal combustion engine wherein variously different forces are applied to the respective second rocker arms (12 in Fig. 12) depending upon the operation position of each valve, the controlling force can be rapidly delivered with suffering almost no influences thereof. Therefore, highly accurate and responsive control can be conducted even with a multi-cylinder internal combustion engine.

Additionally, the motor 30 used in this example as a means for driving the shaft 24 for altering valve lift timing may be replaced by an air cylinder as used in the next ninth example.

Fig. 15 illustrates a mechanism for preventing axial deviation in the valve operating system of the present invention. Signs correspond to those in Figs. 14 and 16, with numeral 8-1 designating a slidable bearing portion, 8-2 a bearing metal, 23-5 bolt holes and 23-6 a projection. The roller 13-1 in contact with cam 9 is fitted to the second rocker arm 12 (not shown in Fig. 15 for avoiding complication) which is axially supported by the shaft 15.

The shaft 8 has the slidable bearing portion 8-1 having a slightly larger diameter at a position at which the bracket 23 is engagedly fitted to the shaft 8. On the surface of the slidable bearing portion 8-1 may be provided, if necessary, the bearing metal 8-2 for protecting abrasion. For example, the bearing metal 8-2 is provided when the bracket 23 is made of steel, but not provided when the bracket 14 is made of aluminum.

On the other hand, the bracket 23 has, at the position where it is to be engagedly fitted to the slidable bearing portion 8-1, projections 23-6 with a depression therebetween, the depression being used for the engagement. The engaged fitting of the shaft 8 and the bracket 23 serves to prevent deviation (in the axial direction of the shaft 8). Since no deviation takes place, there occurs no increase in surface-to-surface pressure at the contact surfaces per unit area and, therefore, no damages of the contact surfaces.

(Ninth Example)

Fig. 17 is a perspective view of a main portion of a ninth example of the present invention, and Fig. 18 illustrates a bracket to be engagedly fitted to a cam shaft used in the ninth example. Signs correspond to those in Example 14, with numeral 33 designating an air cylinder, 34 an air pipe, 35 a link, 36 a lever, 37 a gear, 38 and 39 pins, 40 a gear, 41 a bracket engagedly fitted to the cam shaft, 41-1 shaft-penetrating hole, 41-2 a depression for fitting, and L an arrow..

A first difference in comparison from the example shown in Fig. 14 lies in that a gear mechanism (37, 40) is used for delivering the motion of the shaft 24 for altering valve lift timing to the shaft 15. (In the eighth example, a fitting mechanism by the fork lever 26 is used.) The gear 37 is fixedly fitted to the shaft 24 for altering valve lift timing with the aid of pins 38, and the gears 40 are fixedly fitted to both ends of the shaft 15 with the aid of the pins 39. The gears 37 and the gears 40 are engagedly disposed with each other.

A second difference lies in that an air cylinder 33 is used as a driving means for rotating the shaft 24 for altering valve lift timing. (In the eighth example, the motor 30 is used.) A lever 36 is connected to one end of the shaft 24 for altering valve lift timing, and a piston axis is connected to the lever 36 through a link 35. When the link 35 is rotated in one of the directions shown by L by means of the air cylinder 33, a controlling force is delivered through the link lever mechanism, thus the valve lift timing-altering shaft 24 being rotated in the corresponding direction. An air supplied to the air cylinder 33 through an air pipe 34 is controlled by a controller not shown.

A third difference lies in that the bracket 41 is of a merely hanging type as shown in Fig. 18. The shaft 13 penetrates through the shaft-penetrating hole 41-1, and a fitting depression 41-2 is hung upon the shaft 8.

In the ninth example, controlling force for altering valve lift timing is delivered in the followng order: air cylinder 33 (driving means)→link 35→lever 36→shaft 24 for altering valve lift timing→gear 37→gear 40→shaft 13 (final member to be driven).

This force-delivering route is also constituted by mechanically strong constituents and, in this case, too, a highly rigid controlling system is realized.

Additionally, the air cylinder 33 used in this example as a means for driving the shaft 24 for altering valve lift timing may be replaced by a motor as used in the eighth example.

In the eighth and ninth examples, a mechanically strong mechanism such as a gear mechanism or a link lever mechanism is employed as a controlling force-delivering mechanism. Thus, a highly rigid controlling system is realized.

Therefore, even with multi-cylinder internal combustion engines, the controlling force can be delivered rapidly, thereby valve lift timing being able to be altered with high accuracy and responsiveness.

Additionally, in the foregoing examples, since one of the contact surfaces on the driving force-delivering way if of a circular shape with the center of the shaft of the cam which delivers the valve-operating force as its center, the rocker arm in fitting contact with the stem of the valve will not be shifted when the relation between valve-lifting degree and valve lift timing is changed.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all the changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Claims

1. A valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a roller for attaining a rolling contact is provided at least at one of the contacting positions on the driving force-delivering way between a cam for providing a driving force and a valve, and one contact surface on the driving force-delivering way is made a circular surface with the center of said cam as its center.

2. A valve operating system for an internal combustion engine as described in claim 1, which has a first rocker arm having at one end a means for fittingly contacting with the aforesaid stem of the valve and at the other end a circular surface with the center of the aforesaid cam as its center, and a second rocker arm having a rocking fulcrum shiftable upon alteration of valve lift timing and having at the rocking tip end a first roller in contact with said circular surface and a second rc'ler in contact with said cam with both rollers on the same shaft.

3. A valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a bracket, engagedly fitted to a cam shaft, through which a shaft for said rocker arm penetrates at its one end and which is engagedly fitted to a shaft of the cam functioning as a source of driving force is provided, said engaged fitting being formed by a combination of a depression and a projection to prevent deviation in the axial direction of the shaft.

4. A valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a bracket, engagedly fitted to a cam shaft, which intervenes between said shaft and a cam shaft; a valve lift timing-altering shaft rockable by the force delivered from a driving means; and a fork lever one end of which is fixed to said valve lift timing-altering shaft and whose fork grooves are fitted to said shaft are provided.

5. A valve operating system for an internal combustion engine having a rocker arm permitting alteration of valve lift timing by shifting the rocking fulcrum, in which a bracket, engagedly fitted to a cam shaft, which intervenes between said shaft and a cam shaft; a valve lift timing-altering shaft rockable by the force delivered from a driving means; and a gear mechanism having a gear fixed to said valve lift timing-altering shaft and a gear engaged with the gear and fixed to said shaft.

Fig. 1

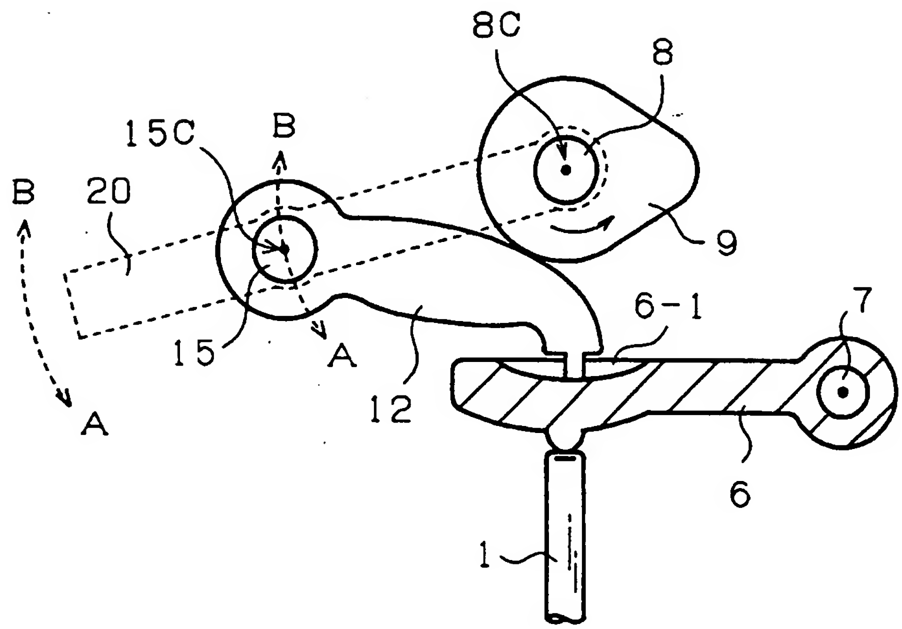

8C
8
15C
B
B
20
9
6-1
7
15
A
12
A
6
1

Fig. 2

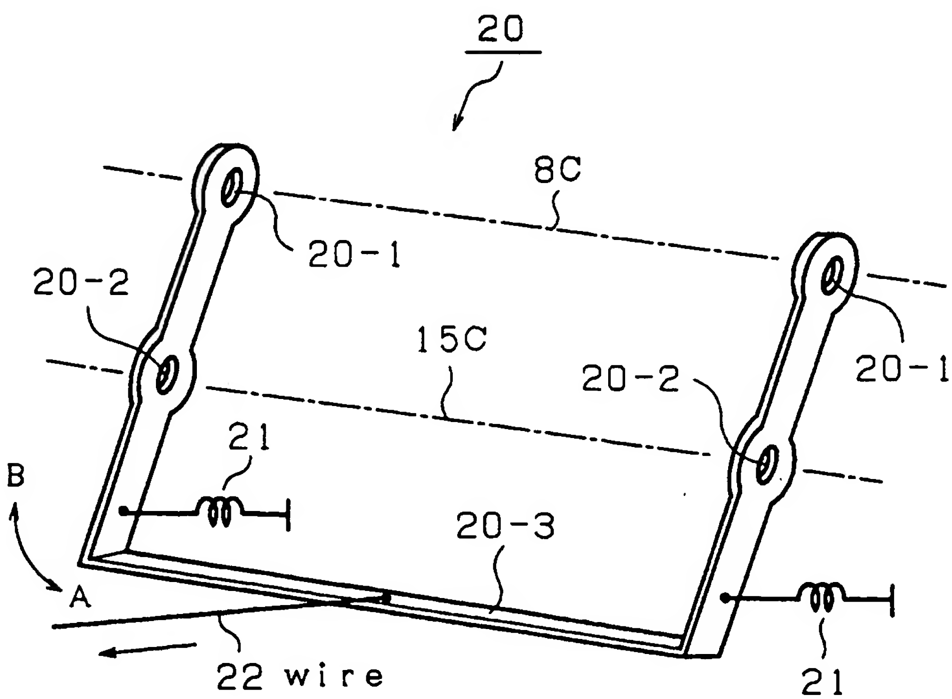

20
8C
20-1
20-2
15C
20-2
20-1
21
B
20-3
A
22 wire
21

Fig. 3

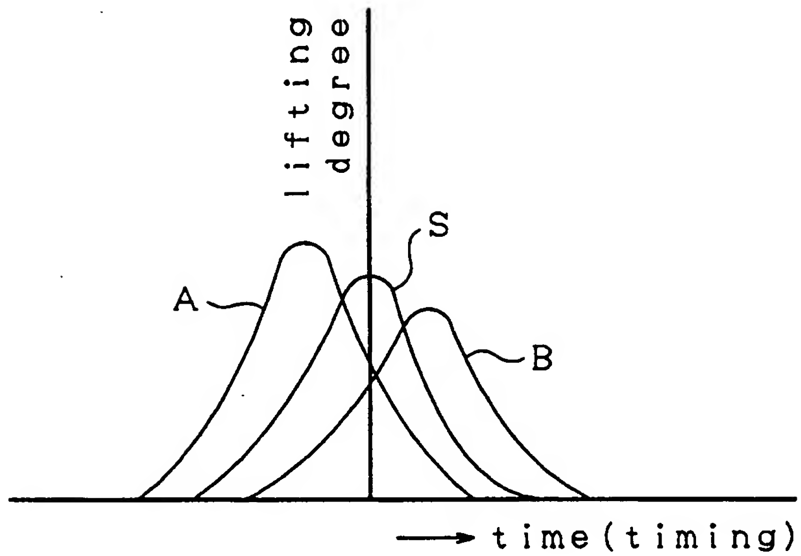


Fig. 4

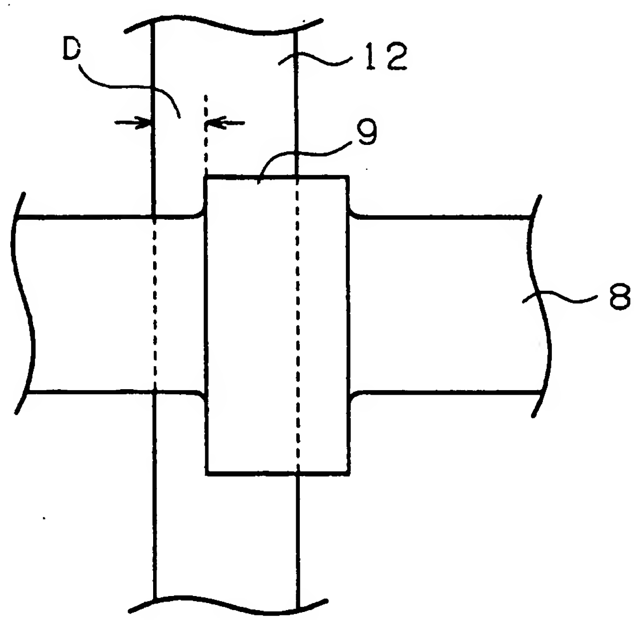


Fig. 5

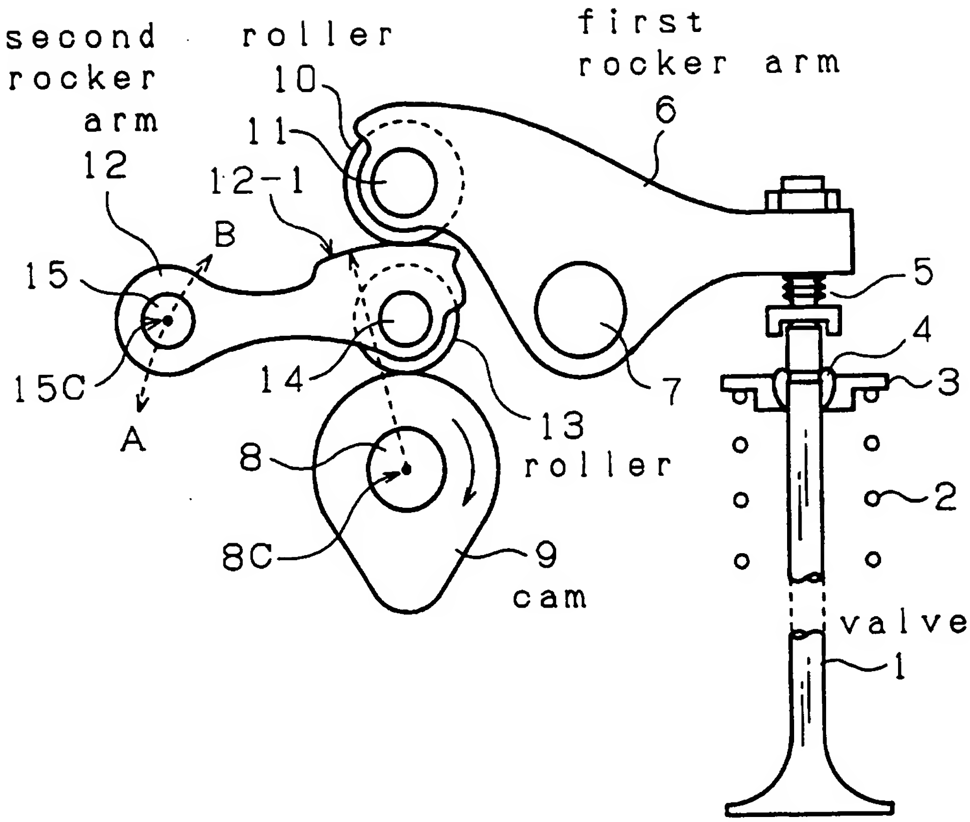

second rocker arm
12
roller
10
11
12-1
first rocker arm
6
B
15
15C
A
14
13
roller
8
8C
9
cam
7
5
4
3
2
valve
1

Fig. 6

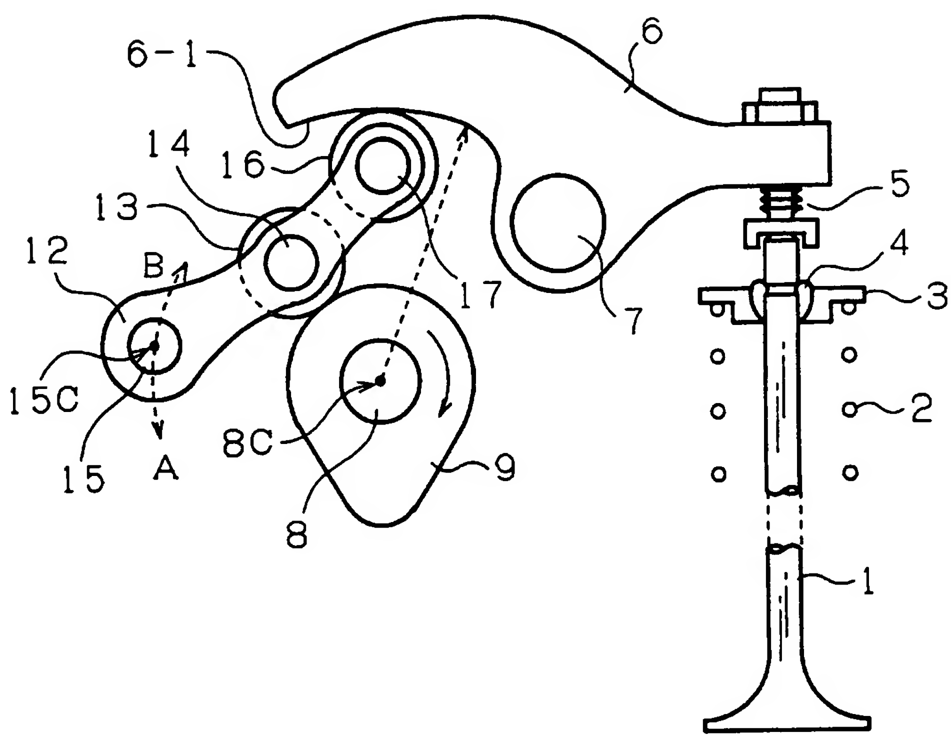
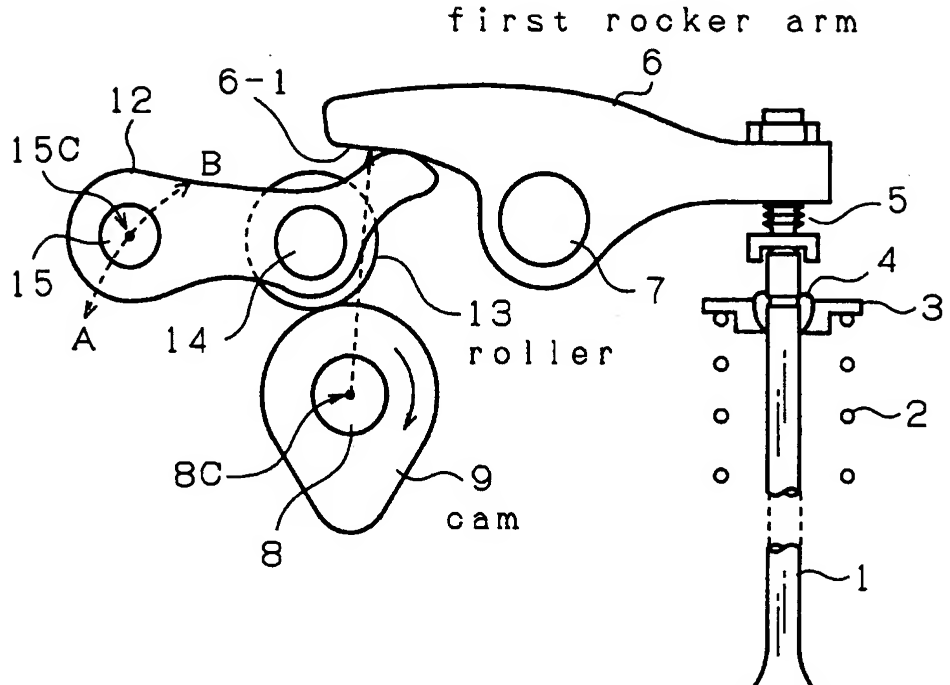
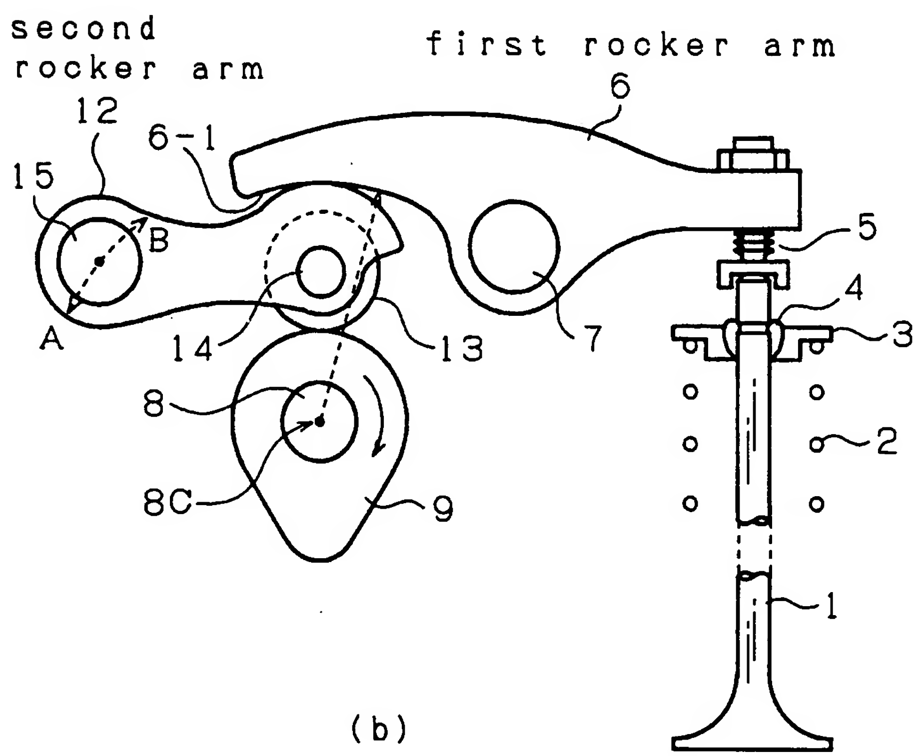


Fig. 7


first rocker arm
6
6-1
12
15C
B
15
A
14
13
roller
7
5
4
3
2
8C
9
cam
8
1

(a)


second
rocker arm
first rocker arm
6
12
6-1
15
B
A
14
13
7
5
4
3
8
2
8C
9
1

(b)

Fig. 8

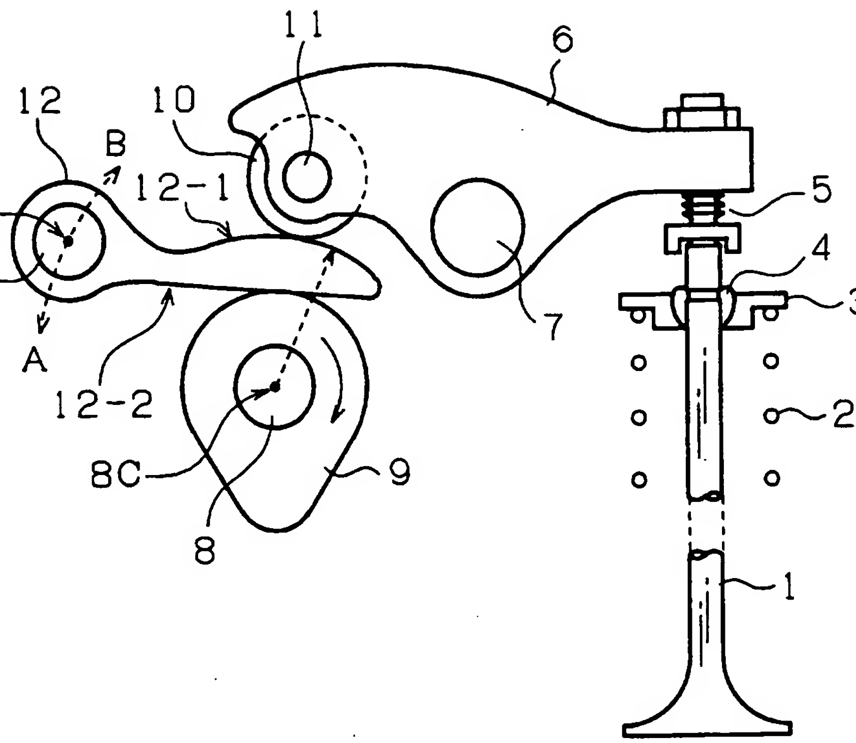


Fig. 9

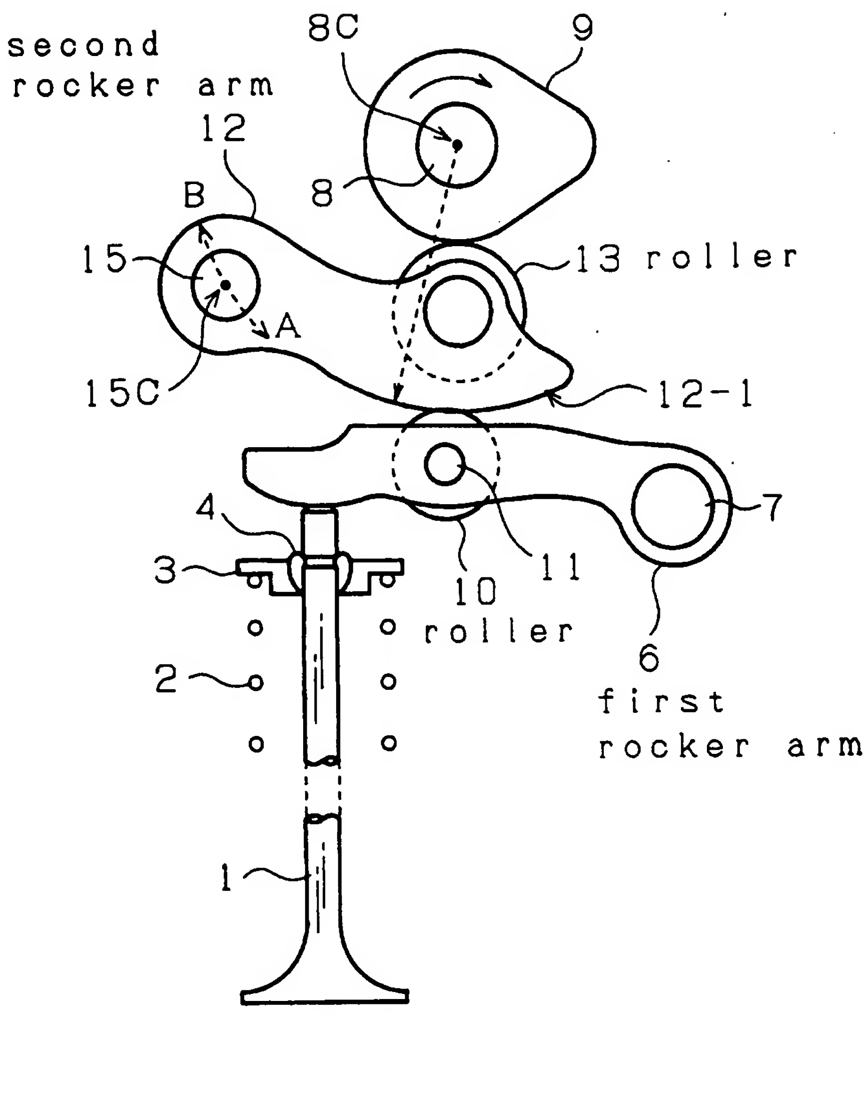

second rocker arm
8C
9
12
B
8
15
13 roller
A
15C
12-1
4
7
3
11
10 roller
2
6
first rocker arm
1

Fig. 10

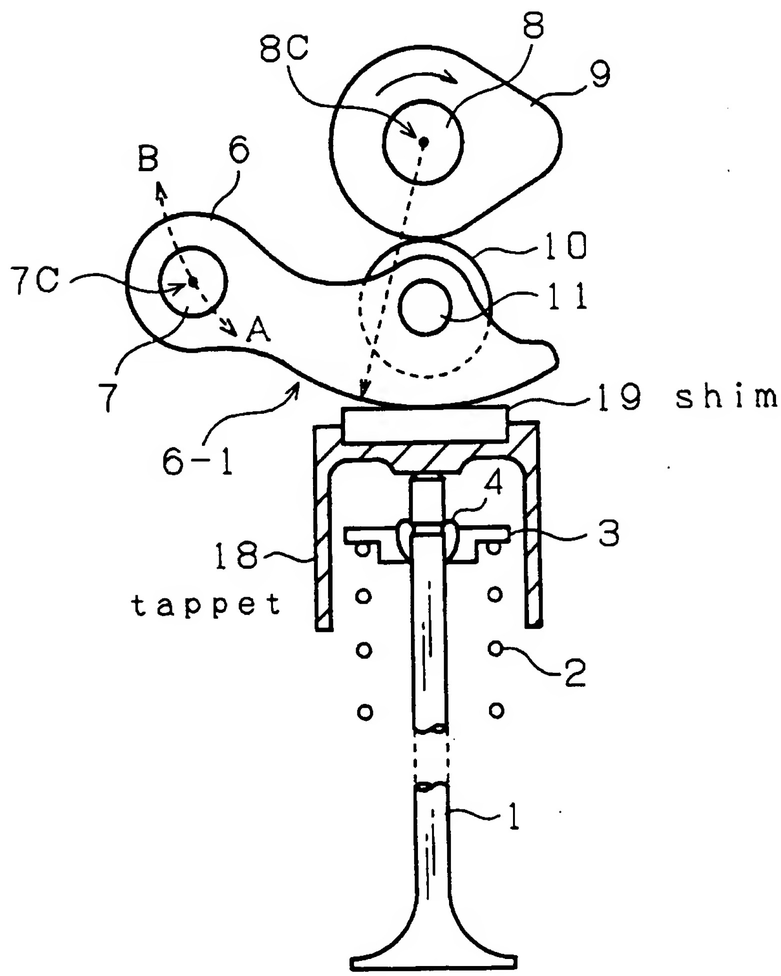


Fig. 11

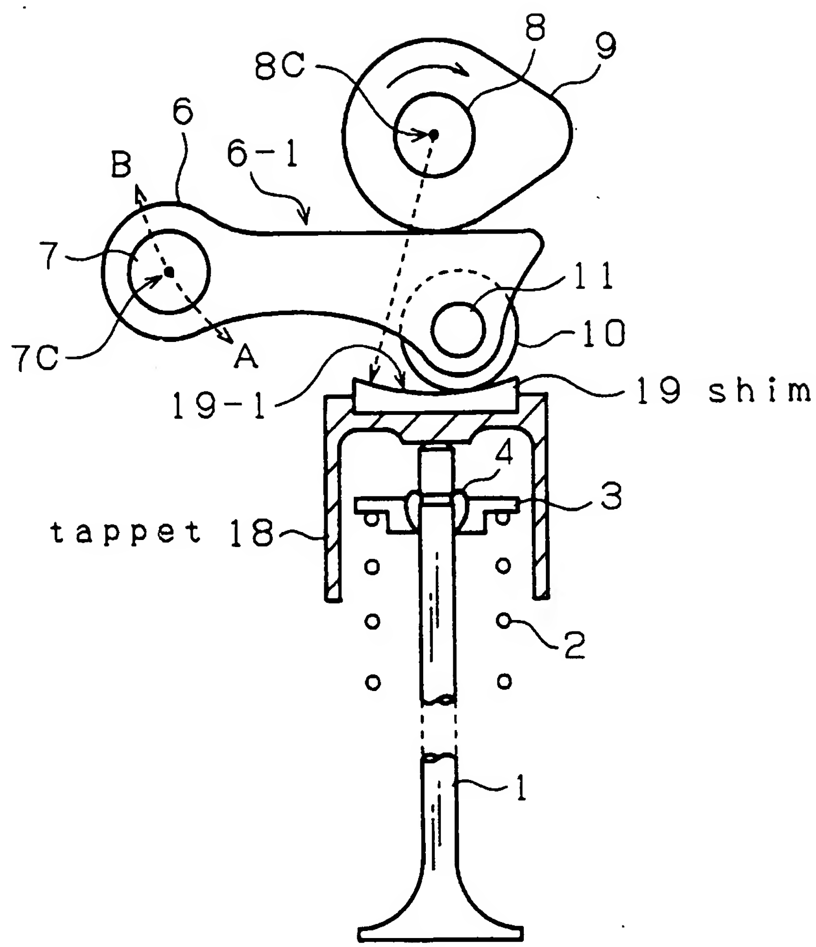


Fig. 12

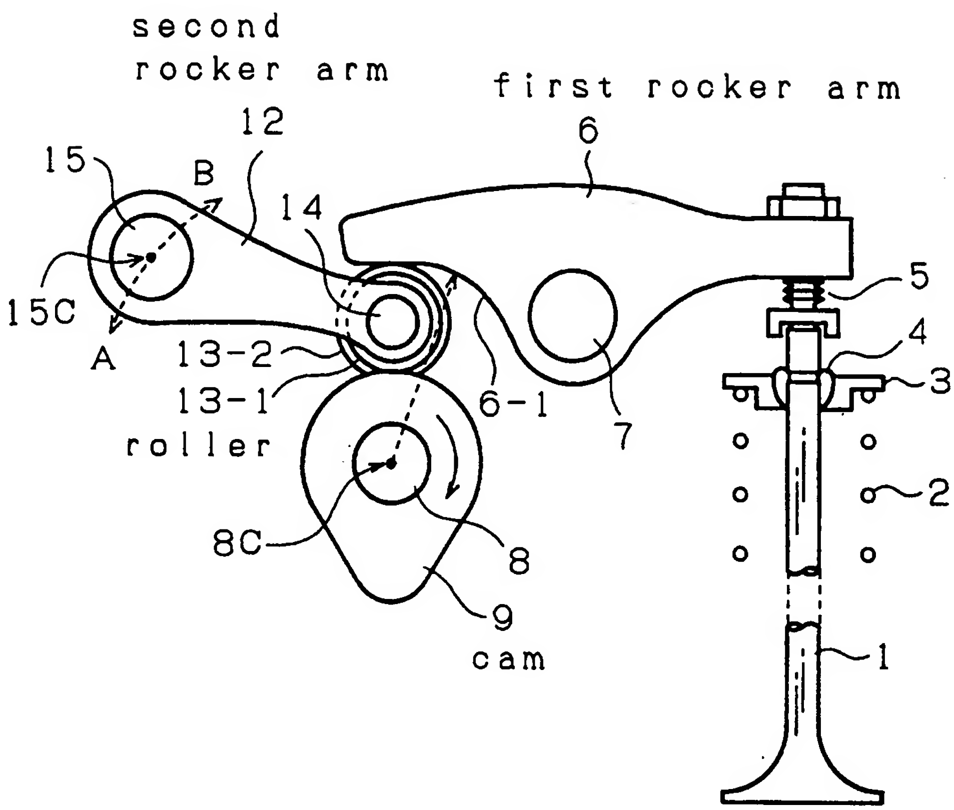

second
rocker arm
first rocker arm
12
6
15
B
14
5
15C
A
13-2
4
3
13-1
6-1
roller
7
2
8C
8
9
cam
1

Fig. 13

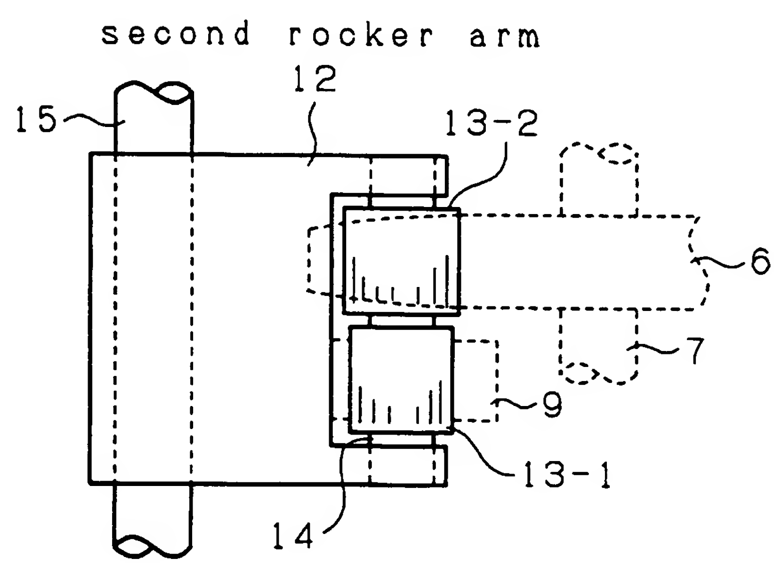

second rocker arm
12
15
13-2
6
7
9
13-1
14

Fig. 14

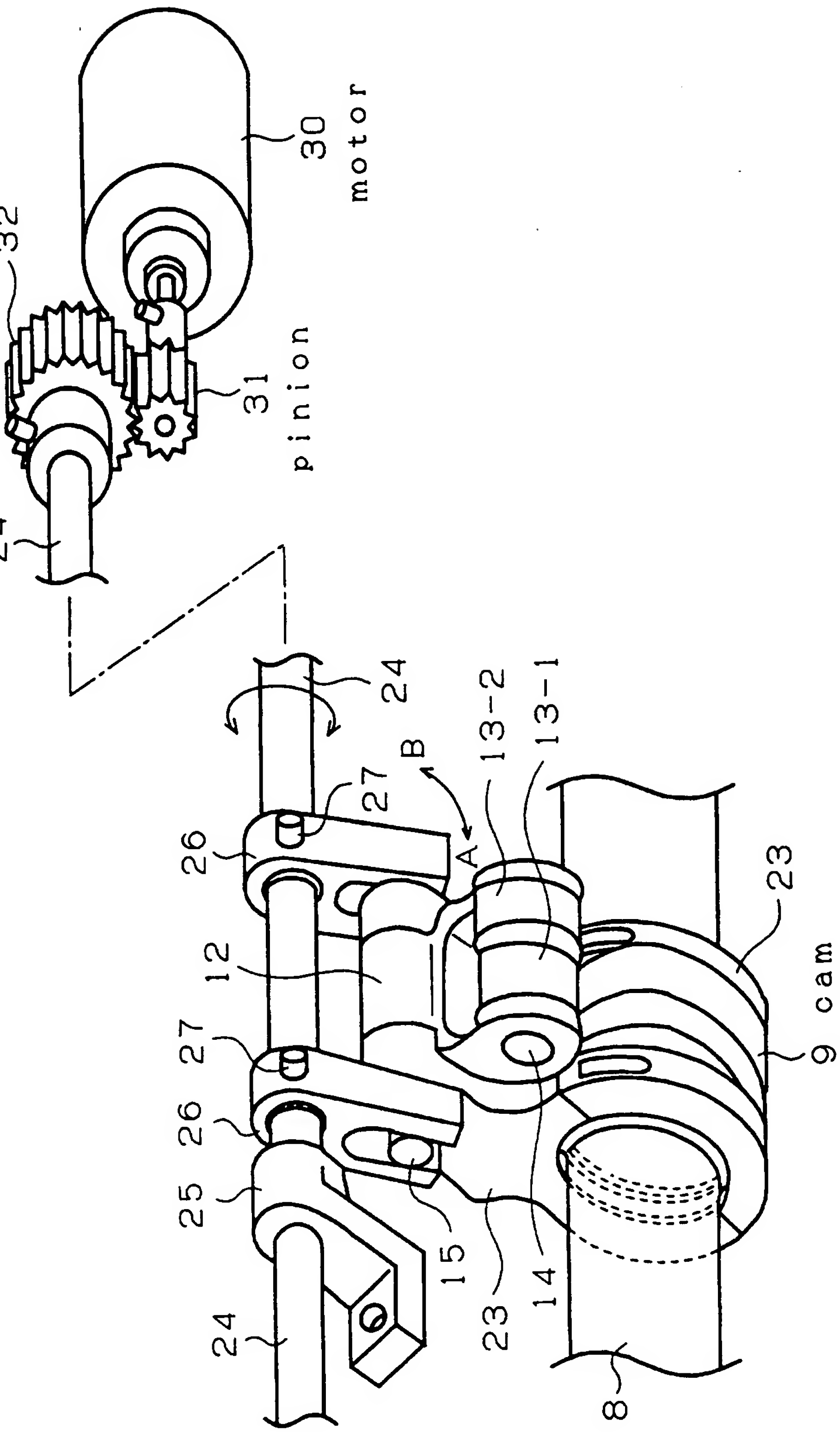

30
motor
32
gear
31
pinion
24
24
B
13-2
13-1
27
26
A
23
12
27
26
25
15
23
14
9 cam
24
8

Fig. 15

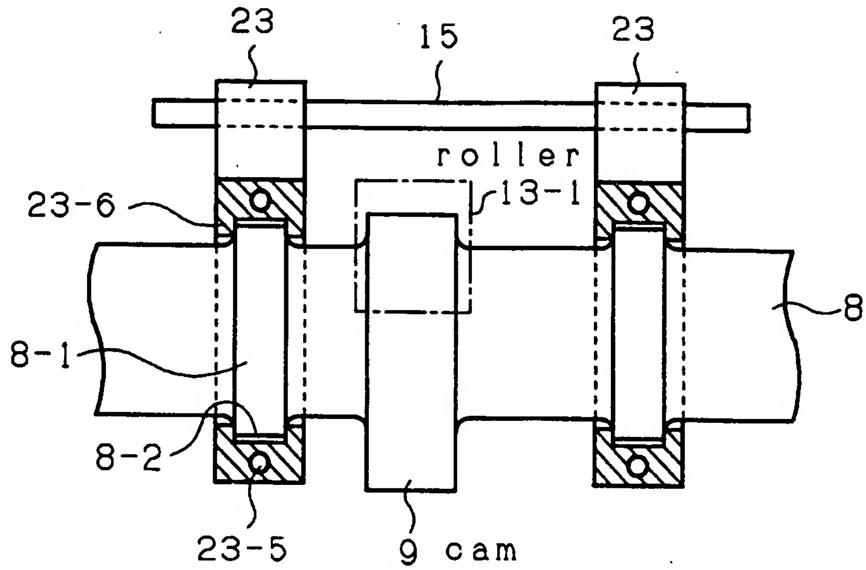
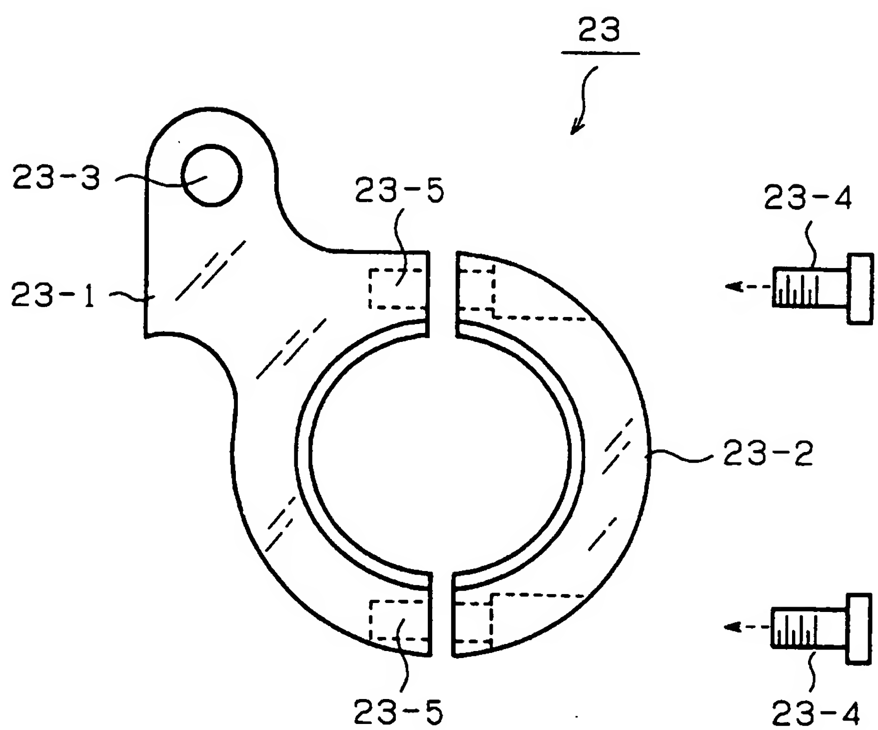

23
15
23
roller
23-6
13-1
8
8-1
8-2
23-5
9 cam

Fig. 16


23
23-3
23-5
23-4
23-1
23-2
23-5
23-4

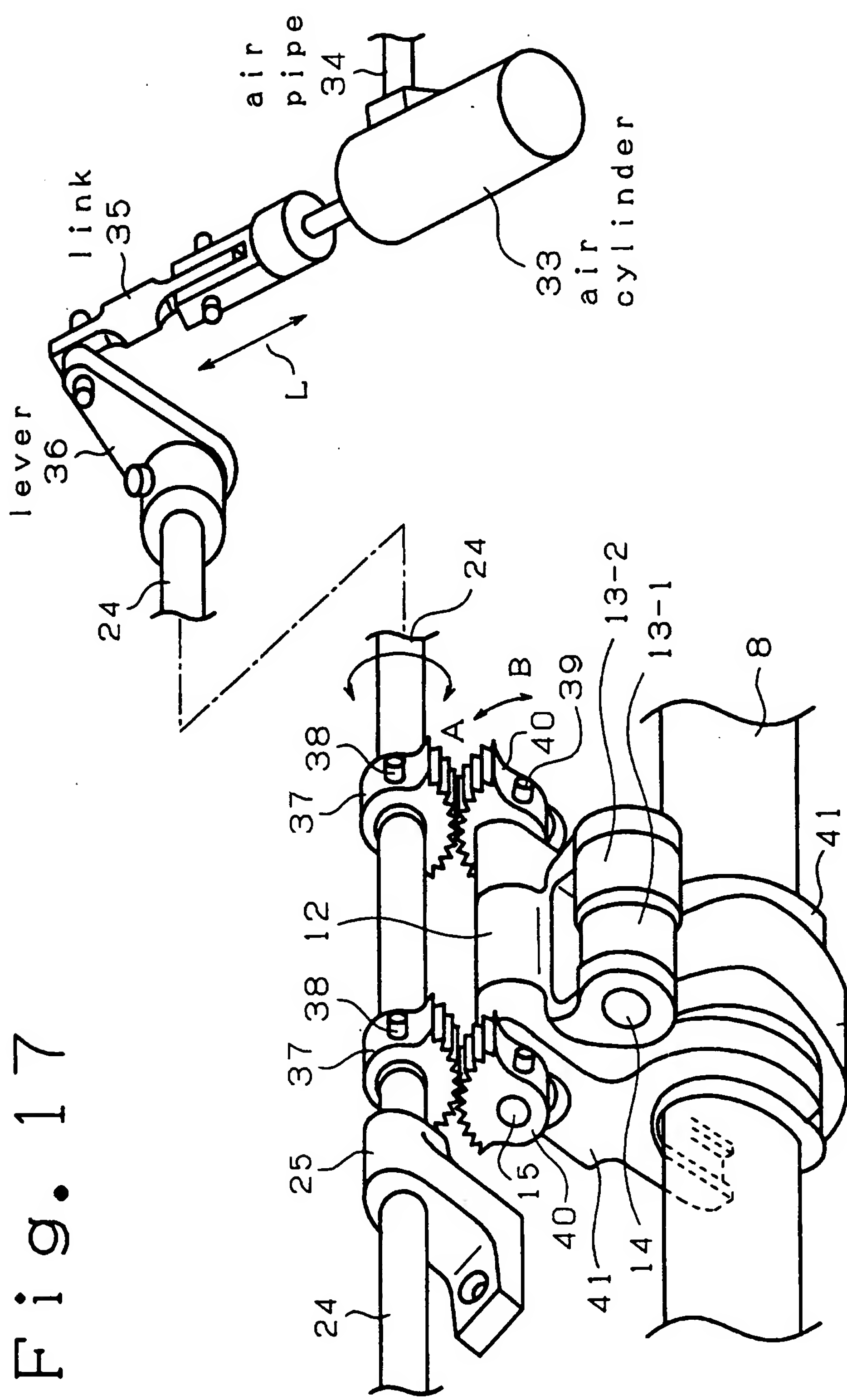
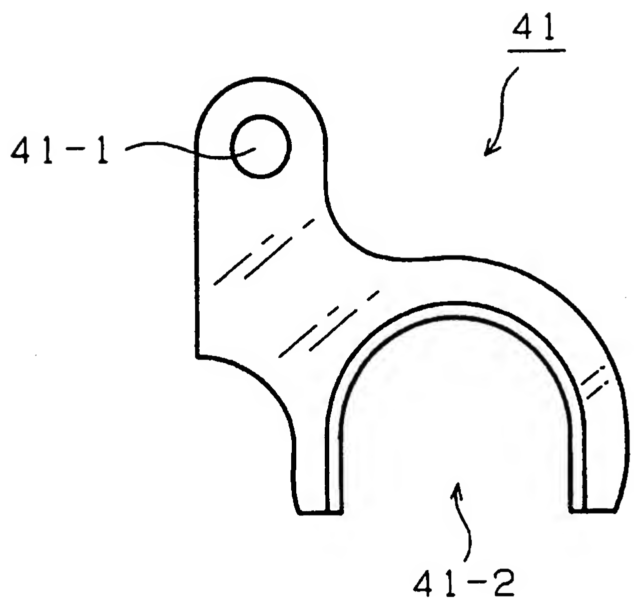

air pipe
34
link
35
33
air cylinder
lever
36
L
24
24
B
A
38
39
40
37
38
12
13-2
13-1
8
41
9 cam
37
25
15
40
41
14
24

Fig. 17

Fig. 18



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 9507

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	WO-A-94 13935 (BAYERISCHE MOTOREN WERKE AG)	1,2	F01L13/00
A	* page 11, line 9 - page 12, line 24; figure 3 * ---	3	
A	DE-A-22 56 093 (DAIMLER BENZ AG) * the whole document * ---	1	
A	FR-A-2 357 731 (CHRYSLER FRANCE) * figure 1 * ---	1	
A	DE-C-42 43 169 (MERCEDES BENZ AG) * the whole document * ---	1	
A	DE-A-26 29 554 (DAIMLER BENZ AG) -----		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	8 March 1996	Klinger, T

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